PATENT ABSTRACTS OF JAPAN

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(71)Applicant : EBARA CORP
EBARA DENSAN:KK
(72)Inventor : NAKAMURA ATSUSHI
HARADA MINORU

(54) OZONE GENERATING METHOD AND DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To efficiently obtain ozone by impressing a high pulse voltage between a high-voltage electrode and a grounded electrode to form a steep discharge current after an electric discharge is started and generating concd. ozone.
SOLUTION: An ozonizer formed with a discharge electrode part consisting of a DC power source, an inverter, a current limit reactor, a boost-up transformer and the high-voltage electrode and grounded electrode with a dielectric in between is used. An AC pulse voltage generated in the inverter with an input to the power source is impressed on the discharge electrode part through the current limit reactor and boost transformer. After an electric discharge is started by the rising of a high-voltage pulse, a discharge current rises at a sufficiently higher rate than an ionizing rate due to a steep pulse current, hence an ozonizing reaction proceeds before ion is generated, and concd. ozone is efficiently obtained.

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CLAIMS

[Claim(s)]
[Claim 1] The ozone generating approach characterized by generating high-concentration ozone in the approach of a dielectric being made to intervene between a high voltage electrode and an earth electrode, and impressing a high voltage pulse voltage between this high voltage electrode and an earth electrode, making generate silent discharge or creeping discharge, making pass oxygen gas in this discharge space, and generating ozone by forming the steep discharge current at the time of the standup of said high voltage pulse.
[Claim 2] The ozone generator characterized by having a means to start the discharge current steeply, between said discharge electrodes after discharge starting by the standup of said alternating current pulse voltage in the ozone generator which consists of the DC-power-supply section, the inverter section which generates an alternating current pulse voltage, a pressure-up transformer which carries out pressure up of the alternating current pulse voltage generated in this inverter section, and the discharge electrode section connected to the outgoing end of this pressure-up transformer.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention makes a dielectric intervene so that the generating approach of ozone and equipment by silent discharge or creeping discharge may be started, especially the opening section may be formed between two electrodes in a high voltage electrode and an earth electrode, and it relates discharge to the ozone generating approach and equipment which generate a lifting and high-concentration ozone by impressing a high voltage pulse voltage, passing oxygen gas between two electrodes.
[0002]
[Description of the Prior Art] Drawing 4 shows the circuitry of the conventional ozone generator. A commercial alternating current power source is rectified in the converter section which is not illustrated, and the DC-power-supply section 11 is constituted. The DC-power-supply section 11 supplies DC power supply to the inverter section 12, and an alternating current pulse voltage is formed during the middle points c and d of the bridge circuit. The alternating current pulse voltage formed in the inverter section is changed into a high voltage pulse voltage by the pressure-up transformer 13, and is impressed to the discharge electrode section 15 which made the dielectric intervene between a high voltage electrode and an earth electrode. The current-limiting reactor La is connected between the pressure-up transformer 13 and the inverter section 12. This current-limiting reactor La is formed for the object of restricting and protecting that a transitional current flows to the switching element of the inverter section 12.
[0003] Drawing 5 shows the wave of the current I which flows to the electrical potential difference V and discharge electrode which are impressed to the discharge electrode by the circuit mentioned above. Since the alternating current pulse formed of the inverter section 12 is impressed through a current-limiting reactor 14 and the pressure-up transformer 13, the electrical potential difference V impressed to the ends of a discharge electrode 15 serves as a wave of abbreviation trapezoidal shape which is illustrated. Since a discharge electrode 15 makes a dielectric intervene between a high voltage electrode and an earth electrode, it serves as a capacitive load shown in an equal circuit which is illustrated. Among the circuit shown by the dotted line in drawing of a discharge electrode 15, Switch S is in a discharge condition, when having closed, it is shown that the discharge current flows through the equivalent discharge resistance R, and when open, the condition of not discharging is shown. For the current I which flows to a discharge electrode 15, since the load is capacitive, the charging current flows first, and an electrical potential difference V is an electrical potential difference Eb by the standup. If it becomes, the discharge current will flow. The discharge current will flow between conducting periods T, discharge will stop it after that, and a current will not flow. For this reason, Current I serves as a wave of the shape of a pulse with comparatively low peak value which is illustrated. In addition, the standup of a voltage waveform V is breakdown voltage Eb. When it becomes large, the curve which starts goes to sleep for a while because [of the voltage drop of the resistance component by the discharge current].
[0004]
[Problem(s) to be Solved by the Invention] In the circuitry of such a conventional ozone generator, when ozone was generated by using high grade oxygen gas as a raw material, ion was generated at the time of the standup of a high voltage pulse voltage, generating of ozone was barred, and there was a problem that energy efficiency is bad, and an ozone level decreased and stability was missing with a charging time value. Since this had restricted the current in the circuitry of the ozone generator mentioned above using the current-limiting reactor La, as it shows drawing 5 , the standup of the discharge current becomes blunt, and the standup of a high voltage pulse

voltage becomes blunt. And [redacted] concentration increases between discha[redacted] electrodes at the time of discharge, concentration of electrons decreases, and the amount of excited molecules decreases. For this reason, there was a problem that ozone became is hard to be generated.

[0005] Moreover, the 3rd matter, such as nitrogen gas (N2), was needed for generation of ozone. It is for the 3rd matter to carry out the catalyst-work which can prevent accumulating an ionized layer on the surface of an electrode if ion concentration increases, and controlling an ozone generation reaction. and -- therefore, the facility which passes the gas and gas to add was needed, and there was a problem that a running cost was high and equipment became large-sized.

[0006] In view of the situation mentioned above, it succeeded in this invention, and before it starts the discharge current to sudden ** at a rate earlier than the generation rate of ion and ion generates by this at the time of discharge, it aims at offering the generating approach of ozone and equipment which can perform stability and high-concentration ozone generation.

[0007]

[Means for Solving the Problem] In the approach of a dielectric being made to intervene between a high voltage electrode and an earth electrode, and impressing a high voltage pulse voltage between this high voltage electrode and an earth electrode, making generate silent discharge or creeping discharge, making pass oxygen gas in this discharge space, and generating ozone, the ozone generating approach of this invention is forming the steep discharge current at the time of the standup of said high voltage pulse, and is characterized by generating high-concentration ozone.

[0008] Moreover, the ozone generator of this invention is characterized by having a means to start the discharge current steeply, between said discharge electrodes after discharge starting by the standup of said alternating current pulse voltage in the ozone generator which consists of the DC-power-supply section, the inverter section which generates an alternating current pulse voltage, a pressure-up transformer which carries out pressure up of the alternating current pulse voltage generated in this inverter section, and the discharge electrode section connected to the outgoing end of this pressure-up transformer.

[0009] Before the ion which controls generating of ozone by starting the discharge current to sudden ** at a rate earlier than the generation rate of ion is generated, stability can be made to generate ozone in large quantities according to this invention mentioned above.

[0010]

[Example] Hereafter, it explains, referring to an attached drawing 1 thru/or drawing 3 about one example of this invention.

[0011] Drawing 1 shows the circuitry of the ozone generator of the 1st example of this invention, and drawing 2 shows the electrical potential difference V impressed to the discharge electrode by the circuitry, and Current I. Also in this example, the fundamental configuration of the circuit which consists of the DC-power-supply section 11, the inverter section 12, a pressure-up transformer 13, and discharge electrode 15 grade is the same as that of a Prior art, and the explanation which gave the same sign to the same element and overlapped is omitted. It sets to this example and is Reactor Ls about the current-limiting reactor section 14. Lb A series connection and reactor La It considers as series parallel connection. In this, it is a current-limiting reactor Ls. Breakdown voltage Eb It is constituted so that that inductance may be saturated with the current value when reaching.

[0012] Therefore, the reactor Lac between Points a and c is [a series circuit with Reactors Ls and Lb, and] Reactor La. Since it becomes the series parallel circuit by which parallel connection was carried out, the synthetic reactor value expression is set to (1).

[Equation 1]

$$Lac = \frac{1}{\frac{1}{Lb+Ls} + \frac{1}{La}} = \frac{La\,(Lb+Ls)}{La+Lb+Ls}$$

Breakdown voltage Eb If it exceeds, since Reactor LS is saturated, it will become a formula (2).

[Equation 2]

$$Lac = \frac{1}{\frac{1}{Lb} + \frac{1}{La}} = \frac{LaLb}{La+Lb}$$

[0013] Furthermore, if the solid-state-switching component of the inverter section becomes off, the current-limiting reactor Lac between Points a and c will emit energy. Energy is Reactor Ls first then, although returned to a power source. Since it is saturated, the reactor between Points a and c is Reactor La. Reactor Lb It becomes a parallel circuit. And reactor Ls When the flowing current decreases and an impedance comes to be recovered, the reactor between Points a and c comes to be shown by the formula (1).
[0014] The current which will flow to a discharge electrode 15 if a current-limiting reactor changes as mentioned above is breakdown voltage Eb, as shown in drawing 2 . It comes to start steeply in the passed place. According to this steep impulse-current, since the discharge current starts at a rate sufficiently earlier than an ion generation rate between the high voltage electrodes and earth electrodes of a discharge electrode 15, before ion is generated, an ozone generation reaction can fully be performed, and the ozone of a large quantity can be generated efficiently.
[0015] Drawing 3 shows the circuitry of the ozone generator of the 2nd example of this invention. At this example, it is a current-limiting reactor La. A switching element 18 is connected to juxtaposition between the DC-power-supply sections 11. Immediately after starting discharge with a discharge electrode 15, steep pulse current can be supplied to a discharge electrode 15 through the pressure-up transformer 13 by making a switching element 18 turn on. Since the discharge current as well as the 1st example starts at a rate sufficiently earlier than an ion generation rate, before ion is generated by this steep pulse current, according to it, stability and high-concentration ozone generation can be performed.
[0016] The above-mentioned example shows two examples of the technique of passing the steep discharge current between the discharge electrodes of an ozone generator after discharge starting. In order to realize the main point of not only these examples but this invention, it cannot be overemphasized that various deformation examples are possible.
[0017]
[Effect of the Invention] Ozone generation of stability high concentration is attained without spoiling power-source effectiveness by starting the discharge current steeply after discharge starting between the discharge electrodes of an ozone generator according to this invention, as explained above. Moreover, although the 3rd matter, such as conventional, for example, N, 2 gas, was needed when high-concentration ozone was generated, high-concentration ozone generation is attained, without using such 3rd matter, if this invention is caused. For this reason, the facility which passes N2 gas, for example becomes unnecessary, and the miniaturization and cost cut of an ozone generator of it are attained.

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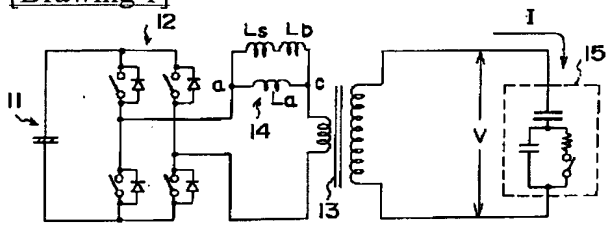
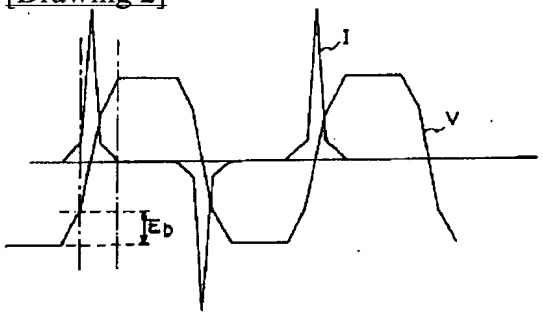
DRAWINGS

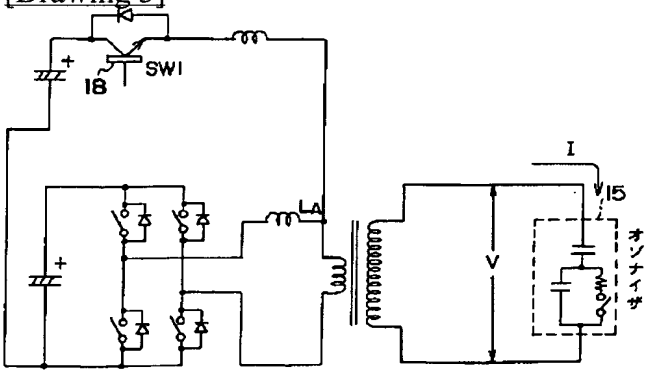
[Drawing 1]



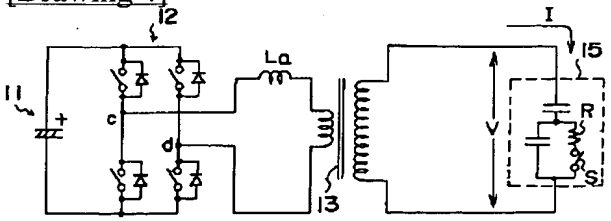
[Drawing 2]



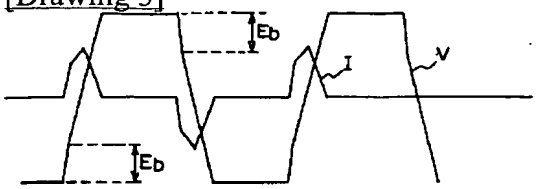
[Drawing 3]



[Drawing 4]



[Drawing 5]



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(71)出願人　000000239
株式会社荏原製作所
東京都大田区羽田旭町11番１号

(71)出願人　000140111
株式会社荏原電産
東京都大田区羽田旭町11番１号

(72)発明者　中村　淳
神奈川県藤沢市本藤沢４丁目１番１号　株式会社荏原電産内

(72)発明者　原田　稔
東京都大田区羽田旭町11番１号　株式会社荏原製作所内

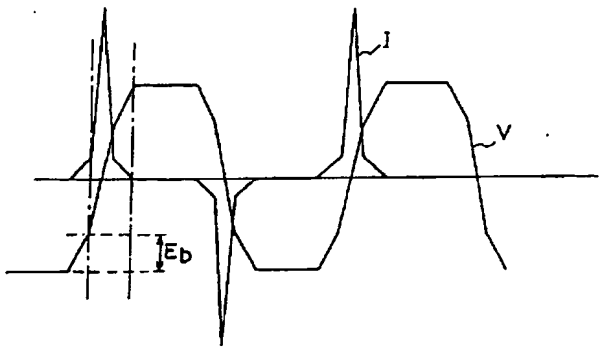
(74)代理人　弁理士　渡邉　勇　（外２名）

(54)【発明の名称】　オゾン発生方法及び装置

(57)【要約】

【課題】　放電時にイオンの生成速度より早い速度で放電電流を急峻に立ち上げ、安定且つ高濃度のオゾン生成ができるオゾンの生成方法及び装置を提供する。

【解決手段】　高圧電極と接地電極との間に誘電体を介在させ、高圧電極と接地電極との間に高圧パルス電圧を印加して無声放電又は沿面放電を発生させ、放電空間内に酸素ガスを通過させてオゾンを生成する方法において、高圧パルスの立ち上がり時に急峻な放電電流を形成することで、高濃度のオゾンを生成する。



【特許請求の範囲】

【請求項１】　高圧電極と接地電極との間に誘電体を介在させ、該高圧電極と接地電極との間に高圧パルス電圧を印加して無声放電又は沿面放電を発生させ、該放電空間内に酸素ガスを通過させてオゾンを生成する方法において、前記高圧パルスの立ち上がり時に急峻な放電電流を形成することで、高濃度のオゾンを生成することを特徴とするオゾン発生方法。

【請求項２】　直流電源部と、交流パルス電圧を生成するインバータ部と、該インバータ部で生成された交流パルス電圧を昇圧する昇圧トランスと、該昇圧トランスの出力端に接続された放電電極部とからなるオゾン発生装置において、前記交流パルス電圧の立ち上がりによる放電開始後に、前記放電電極間に放電電流を急峻に立ち上げる手段を備えたことを特徴とするオゾン発生装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は無声放電又は沿面放電によるオゾンの発生方法及び装置に係り、特に高圧電極と接地電極とを両電極間に空隙部が形成されるように誘電体を介在させ、両電極間に酸素ガスを流しつつ高圧パルス電圧を印加することにより放電を起こし、高濃度のオゾンを生成するオゾン発生方法及び装置に関する。

【０００２】

【従来の技術】図４は、従来のオゾン発生装置の回路構成を示す。図示していないコンバータ部で商用交流電源が整流され、直流電源部１１が構成される。直流電源部１１は、インバータ部１２に直流電源を供給し、そのブリッジ回路の中点ｃ，ｄ間に交流パルス電圧が形成される。インバータ部で形成された交流パルス電圧は、昇圧トランス１３により高圧パルス電圧に変換され、高圧電極と接地電極との間に誘電体を介在させた放電電極部１５に印加される。昇圧トランス１３とインバータ部１２との間には、限流リアクトルＬａが接続されている。この限流リアクトルＬａは、インバータ部１２のスイッチング素子に過渡的な電流が流れることを制限して保護する等の目的で設けたものである。

【０００３】図５は、上述した回路による放電電極に印加される電圧Ｖ及び放電電極に流れる電流Ｉの波形を示す。放電電極１５の両端に印加される電圧Ｖは、インバータ部１２によって形成された交流パルスが、限流リアクトル１４及び昇圧トランス１３を経て印加されるため、図示するような略台形状の波形となる。放電電極１５は、高圧電極と接地電極との間に誘電体を介在させたものであるので、図示するような等価回路に示す容量性の負荷となる。放電電極１５の図中の点線で示す回路中、スイッチＳは、閉じている時には放電状態であり、等価的な放電抵抗Ｒを介して放電電流が流れることを示し、開いている時は放電されていない状態を示す。放電電極１５に流れる電流Ｉは、負荷が容量性であるため、まず充電電流が流れ、電圧Ｖがその立ち上がりで電圧Ｅｂになると放電電流が流れる。放電電流は放電期間Ｔの間に流れ、その後は放電が停止して電流が流れなくなる。このため、電流Ｉは図示するような比較的波高値の低いパルス状の波形となる。なお、電圧波形Ｖの立上りが放電開始電圧Ｅｂよりも大きくなった時に、立ち上がりのカーブが少し寝てくるのは、放電電流による抵抗成分の電圧降下のためである。

【０００４】

【発明が解決しようとする課題】このような従来のオゾン発生装置の回路構成では、高純度酸素ガスを原料としてオゾンを生成すると、高圧パルス電圧の立上り時にイオンが生成されてオゾンの発生を妨げ、エネルギー効率が悪く、又、放電時間とともにオゾン濃度が減少して安定性に欠けるという問題があった。これは上述したオゾン発生装置の回路構成において、限流リアクトルＬａを用いて電流を制限していたために、図５に示すように放電電流の立上りが鈍くなり、高圧パルス電圧の立上りが鈍くなる。そして放電時に放電電極間でイオン濃度が増加し、電子濃度が減少して励起分子量が減少する。このため、オゾンが生成されにくくなるという問題があった。

【０００５】又、オゾンの生成には例えば窒素ガス（N_2）等の第３の物質が必要とされていた。第３の物質が、イオン濃度が増加すると電極の表面にイオン層が蓄積し、オゾン生成反応を抑制することを防げる触媒的な働きをするためである。そして、そのために添加するガス及びガスを流す設備が必要となり、ランニングコストが高く、装置が大型になるという問題があった。

【０００６】本発明は上述した事情に鑑みて為されたもので、放電時にイオンの生成速度より早い速度で放電電流を急峻に立ち上げ、これによりイオンが生成する前に、安定且つ高濃度のオゾン生成ができるオゾンの発生方法及び装置を提供することを目的とする。

【０００７】

【課題を解決するための手段】本発明のオゾン発生方法は、高圧電極と接地電極との間に誘電体を介在させ、該高圧電極と接地電極との間に高圧パルス電圧を印加して無声放電又は沿面放電を発生させ、該放電空間内に酸素ガスを通過させてオゾンを生成する方法において、前記高圧パルスの立ち上がり時に急峻な放電電流を形成することで、高濃度のオゾンを生成することを特徴とする。

【０００８】又、本発明のオゾン発生装置は、直流電源部と、交流パルス電圧を生成するインバータ部と、該インバータ部で生成された交流パルス電圧を昇圧する昇圧トランスと、該昇圧トランスの出力端に接続された放電電極部とからなるオゾン発生装置において、前記交流パルス電圧の立ち上がりによる放電開始後に、前記放電電極間に放電電流を急峻に立ち上げる手段を備えたことを特徴とする。

【０００９】上述した本発明によれば、放電電流をイオンの生成速度より早い速度で急峻に立上げることにより、オゾンの発生を抑制するイオンが生成される前に、オゾンを大量に、且つ安定に発生させることができる。

【００１０】

【実施例】以下、本発明の一実施例について添付図１乃至図３を参照しながら説明する。

【００１１】図１は、本発明の第１実施例のオゾン発生装置の回路構成を示し、図２はその回路構成による放電電極に印加される電圧Ｖ及び電流Ｉを示す。本実施例においても、直流電源部１１、インバータ部１２、昇圧トランス１３、放電電極１５等からなる回路の基本的構成は従来の技術と同様であり、同一の要素には同一の符号を付して重複した説明を省略する。本実施例においては限流リアクトル部１４を、リアクトルＬｓ とＬｂ との直列接続と、リアクトルＬａ との直並列接続とする。この中で限流リアクトルＬｓ は、放電開始電圧Ｅｂ に達した時の電流値でそのインダクタンスが飽和するように構成されている。

【００１２】従って、点ａ，ｃ間のリアクトルＬａｃは、リアクトルＬｓとＬｂとの直列回路と、リアクトルＬａ とが並列接続された直並列回路となるので、その合成リアクトル値式は（１）となる。

【数１】

$$Lac=\frac{1}{\frac{1}{Lb+Ls}+\frac{1}{La}}=\frac{La\,(Lb+Ls)}{La+Lb+Ls}$$

放電開始電圧Ｅｂ を超えると、リアクトルＬｓが飽和することから式（２）となる。

【数２】

$$Lac=\frac{1}{\frac{1}{Lb}+\frac{1}{La}}=\frac{LaLb}{La+Lb}$$

【００１３】更にインバータ部の半導体スイッチング素子がオフとなると、点ａ，ｃ間の限流リアクトルＬａｃがエネルギーを放出する。エネルギーは電源に戻されるが、その時は先ずリアクトルＬｓ が飽和しているため、点ａ，ｃ間のリアクトルはリアクトルＬａ とリアクトルＬｂ との並列回路となる。そして、リアクトルＬｓ を流れる電流が減少し、インピーダンスが回復するようになると、点ａ，ｃ間のリアクトルは式（１）で示されるようになる。

【００１４】以上のように限流リアクトルが変化すれば、放電電極１５に流れる電流は、図２に示すように放電開始電圧Ｅｂ を過ぎた所で急峻に立ち上がるようになる。この急峻なインパルス的な電流により、放電電極１５の高圧電極と接地電極の間にイオン生成速度よりも十分早い速度で放電電流が立ち上がる事から、イオンが生成される前にオゾン生成反応を十分に行うことができ、大量のオゾンを効率的に発生することができる。

【００１５】図３は、本発明の第２実施例のオゾン発生装置の回路構成を示す。本実施例では、限流リアクトルＬａ に並列にスイッチング素子１８を直流電源部１１との間に接続したものである。放電電極１５で放電が開始された直後に、スイッチング素子１８をオンさせることにより、昇圧トランス１３を介して急峻なパルス電流を放電電極１５に供給することができる。この急峻なパルス電流により、第１実施例と同様にイオン生成速度より十分早い速度で放電電流が立ち上がるので、イオンが生成される前に、安定且つ高濃度のオゾン生成ができる。

【００１６】上記実施例は、放電開始後にオゾン発生装置の放電電極間に急峻な放電電流を流す手法の２つの例を示したものである。これらの実施例に限らず、本発明の主旨を実現するため種々の変形実施例が可能であることは言うまでもない。

【００１７】

【発明の効果】以上に説明したように本発明によれば、オゾン発生装置の放電電極間で、放電開始後急峻に放電電流を立上ることにより、電源効率を損なうことなく、安定高濃度のオゾン生成が可能となる。又、高濃度のオゾンを生成する場合には、従来例えばN_2ガス等の第３物質が必要とされていたが、本発明のよればこのような第３物質を用いることなく高濃度のオゾン生成が可能となる。このため、例えばN_2ガスを流す設備が不要となり、オゾン発生装置の小型化とコストダウンが可能となる。

【図面の簡単な説明】

【図１】本発明の第１実施例のオゾン発生装置の回路図。

【図２】図１の回路による放電電極部の電圧Ｖと電流Ｉの波形を示す図。

【図３】本発明の第２実施例のオゾン発生装置の回路図。

【図４】従来のオゾン発生装置の回路図。

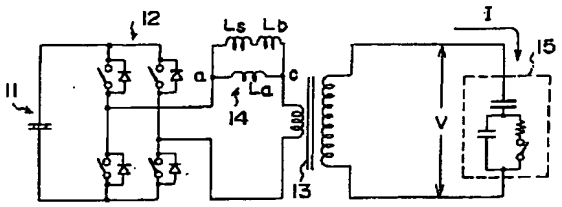
【図５】図４の回路による放電電極部の電圧Ｖと電流Ｉ

の波形を示す図。

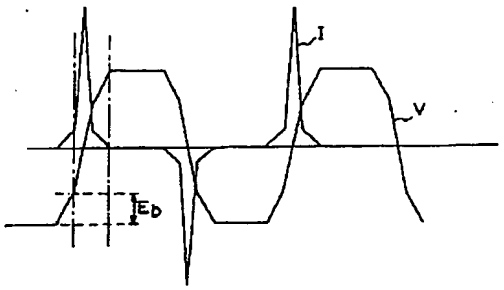
【符号の説明】

１１　　直流電源部
１２　　インバータ部
１３　　昇圧トランス
１４　　限流リアクトル
１５　　放電電極
Ｌａ，Ｌｂ，Ｌｓ　　限流リアクトル

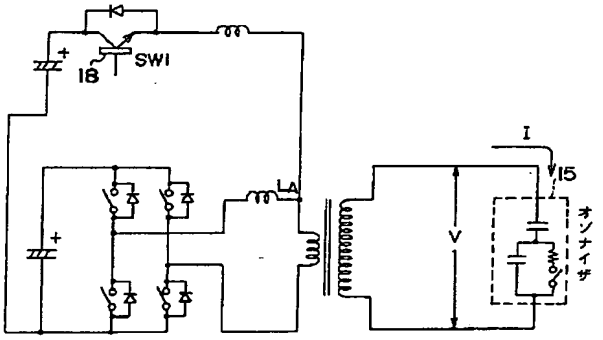
【図１】



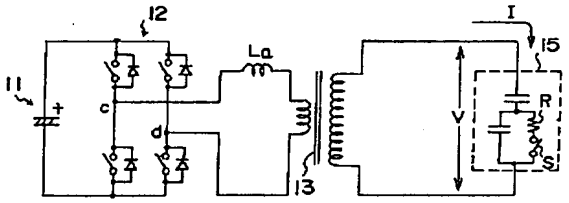
【図２】



【図３】



【図４】



【図５】